SAFETY IN HOISTING AT THE UNITED VERDE MINE PHELPS DODGE CORP., JEROME, ARIZ.

BY ERNEST R. RODRIGUEZ AND ALLEN D. LOOK

* * * * * * * * * * **Information Circular 7612**

UNITED STATES DEPARTMENT OF THE INTERIOR
Oscar L. Chapman, Secretary
BUREAU OF MINES
James Boyd, Director

Work on manuscript completed March 1950. The Bureau of Mines will welcome reprinting of this paper, provided the following footnote acknowledgment is made: "Reprinted from Bureau of Mines Information Circular 7612."

June 1951

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Ernest R. Rodriguez[1/] and Allen D. Look[1/]

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INTRODUCTION

Aside from the humanitarian justification for the prevention of hoisting accidents, the loss of production caused by one serious shaft accident often would more than pay for the cost of the safety measure that would have prevented the accident. Hoisting accidents generally result in greater economic loss than any other type of mine accidnet except haulage or fires.2/

It is the purpose of this paper to record the safety practices in hoisting operations at the United Verde mine, where safety is considered of prime importance. All accidents or near accidents resulting in personal injury, property damage, potential property damage, or any combination of these must be reported. These accidents are investigated thoroughly, and methods or equipment, or both, are corrected. Many of the safety devices on hoisting equipment were designed because of near accidents.

The safety program at this operation is based on the prevention of accidents and break-downs through the installation of proper equipment, adequate maintenance employing frequent periodic inspections, and the proper training of employees by the use of established Codes of Safe Practice.

ACKNOWLEDGMENTS

The authors express their appreciation to the Phelps Dodge Corp. for its cooperation in making available data contained in this paper; also to the mine officials and employees of the United Verde mine for the courtesies shown and for their helpful suggestions and information furnished.

GENERAL INFORMATION

The United Verde mine is on the northeasterly slope of the Black Hills, in central Arizona, in the Jerome mining district, near the town of Jerome.

The copper deposit is a pipelike sulfide body formed by the replacement of sediments and quartz porphyry along a diorite contact by mineralizing solutions following the intrusion of the diorite. The principal ore mineral is chalcopyrite, which, however, is intermixed on the bottom levels with marmatite and sphalerite to produce a copper-zinc ore on these levels. This ore body has been mined for over 60 years and is now believed to be effectively bottomed.

The mine is opened by two adits and three operating shafts. Men and supplies are transported through the 500-level service tunnel, 1,600 feet in length, connecting the 500-level mine surface plant with No. 6 shaft. Ore is transported from the No. 5 shaft bins on the 1,000-foot level through 6,800 feet of tunnel to the outside Hopewell ore bins. The No. 8 shaft is used for both hoisting and service below the 3,000 level.

2/ Bureau of Mines, Accidnets from Hoisting and Haulage in Metal Mines. Metal-Mine Accident-Prevention Course - Sec. 2: Miners' Circular 53, 1945, p.2.

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DESCRIPTION OF SHAFTS AND HOISTS

Ore is hoisted from the 3,000 level, and above, to the 1,000 level through No. 5 shaft, whereas No. 6 service shaft serves the mine from the 500 to the 3,000 level. Below the 3,000 level, No. 8 is a combined service and ore-hoisting shaft. In addition to these, other shafts are maintained for ventilation and emergency exit.

The Arizona code of hoisting signals is posted in the hoist rooms and on all shaft stations. First-aid supplies are available at shaft stations on each operating level.

No. 5 Ore Shaft and Hoist

This shaft is concrete-lined and has two 5- by 5-foot hoisting compartments and one 3-foot 4-inch by 5-foot manway, pipe, and cable compartment. The hoist room, sheave room, and spill pocket are on the 1,000, 800, and 3,150 levels, respectively. A small hoist on the 2,850 level operates a cage and a small skip in the manway compartment from the 3,000 level to the 3,300 level. It serves to hoist muck from the spill pocket to the 3,000-level loading pocket and to hoist men in the emergency exit system. The shaft guides are steel below the 1,800 level and Douglas fir above it. Access to the shaft at each level except the 1,000 level is from one side only, the opening being completely closed off by a heavy steel door. Small steel man doors are provided in the large doors for access. At the 1,000-level station the shaft openings are guarded by expanded-metal gates. Concrete curtain walls divide the hoisting compartments and the manway compartment from the adjacent hoisting compartment.

Ore is hoisted in each hoisting compartment in a 9-ton-capacity skip carrying a 7-ton load from the lower levels. Each skip is equipped with a platform and handhold for use by the skip tender, and a steel bonnet protects men riding the platform. The platform is hinged and, when in position for use by the skip tenders, covers the skip. When in position for hoisting ore, it is latched to the bail in a vertical position. The skips dump automatically into the selector at the top of the dump pockets and are loaded from loading cartridges at each level pocket. The gates on the loading pockets and the loading cartridges are air-operated.

The 1-3/8-inch, 6 x 19, Seale-construction, lang-lay hoisting rope is attached to the skip by means of a spelter-filled socket.

The double-drum, double-clutched hoist is driven by an 800-horsepower, direct-current motor through herringbone gears and is equipped with an automatic lubrication system. The drums are 10 feet in diameter and have 5-foot faces. The direct-current motor is supplied power from a 600-kw. motor-generator set employing a flywheel for equalization of power demands.

The hoist is controlled by means of one power lever and a combination clutch and brake lever for each drum. The power lever has only three positions - lower, neutral, and raise. The power fed to the hoist motor is varied through a controller, which controls the magnitude of the field strength of the generator current. This method gives accurate control of the hoist at any speed or load, with either balanced or unbalanced condition of the load.

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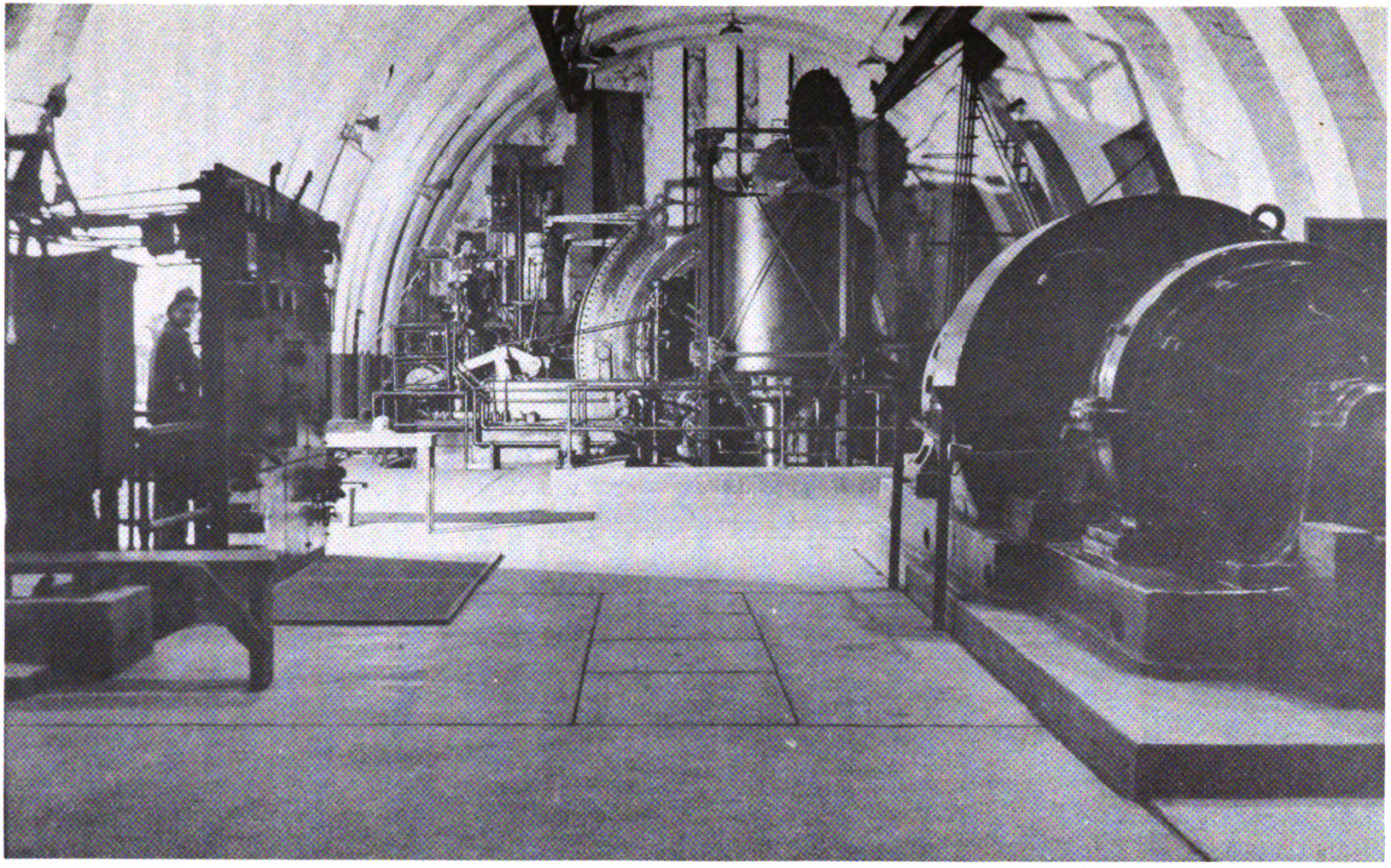

Figure 1. - General view of No. 5 shaft hoist room.

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A dial indicator for each drum serves as a general level indicator, and the drums are marked to show the exact position of the skips. Mechanical recording machines record the position of each skip throughout the day.

The hoist room is of concrete ring construction with concrete floor, and the spaces between rings are gunited (fig. 1). The room is ventilated adequately with fresh air. It is well-lighted, kept clean, and sufficiently quiet so that the engineer can hear the signals easily. Only certain authorized persons are permitted to enter the hoist room. Guard rails are provided around all the machinery and the hoist engineer's stand. A 20-ton crane handles heavy equipment. A stairway with a hand rail passes through the cableway to the sheave room, which is concreted and has a steel floor. The head sheaves are 10 feet in diameter and are guarded by an expanded metal grill 5 feet high.

Safety Devices

Each drum of the No. 5 shaft hoist is equipped with one service brake, which is capable of stopping the load, thus permitting one brake to serve as a spare. These brakes act directly on the hoist drums and are hydraulically operated to open and close automatically by means of weights. Interlocking of the brake and clutch on each drum is accomplished with a common lever, so that it is not possible to release the brake when the clutch is out. This lever has three positions: clutch in--brake off, clutch in--brake on, and clutch out--brake on. A locking device is used to keep the lever in the last position. The brakes are interlocked with the power to the hoist motor, so that if the direct-current circuit breaker, which provides overload protection, is not closed, the brake cannot be released. Electrical interlocking prevents restoration of power if the power lever is not in the neutral position. If the skips should strike an object, the brakes will set automatically. If the overload limits are exceeded, power goes off and the brakes set. Failure of the hydraulic system on the brakes also will cause the brakes to set. There are two pumps in the hydraulic system, each of which is operated half the shift. The brakes are also interlocked with limit switches in the shaft above the dump.

Mechanical overwind and underwind protection is provided. This safety device acts on the controller, forcing it to the neutral position.

A hand-operated "safety-run" switch can be used to cut off the power if the power lever should fail to operate and, as an additional precaution, whenever the hoisting engineer leaves the stand.

Adequate overload protection is provided for both the hoist motor and the motor that drives the generator.

At each loading station, valves in the compressed-air lines are so constructed that they can be locked in the off position. This precludes operation of the loading pocket and cartridge gates by unauthorized persons. Keys are in possession of the skip tenders, who keep all valves locked when not in use.

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All loading pockets and cartridges are provided with sprays for the allaying of dust when ore is transferred. Sprays are operated when necessary, and at the discretion of the skip tenders, through conveniently located foot valves. Two skip tenders work together. A marker is tied to the hoist rope above the skip, so that the ship tender may check the position of the skip before opening the loading cartridge. Whenever rock or other material drops down the shaft, the skip tenders immediately examine the shaft and selector room before proceeding with normal work routine.

No. 6 Service Shaft and Hoist

This shaft is square in section and is divided into an 8- by 13-foot service compartment, a 9-foot 4-inch by 4-foot manway, cable, and pipe compartment, and a 3- by 4-foot counterweight compartment. The hoist room is on the 500 level, the sheave room is at the 400 level, and the sump is just below the 3,000 level. The shaft is concrete-lined to the 1,950 level, and below that level it has concrete rings 30 inches wide, with a space of 40 inches between rings. Curtain walls of concrete above the 1,950 level and of heavy wire screen between rings below are provided between compartments. The guides are of Douglas fir. Heavy steel and expanded-metal sliding gates 5-1/2 feet high, with heavy rail or I-beam reinforcing, are used at the stations (figs. 2 and 3). Men waiting to be hoisted are required to stay back of yellow lines painted on the station walls. Stations are open where ground conditions permit, but steel sets and reinforced concrete are used where necessary. The 500-level station is of concrete construction and has two levels to afford quick loading of men on the double-deck cage. The subway serving the lower deck of the cage opens only on one side of the shaft.

The double-deck cage has three sets of guide shoes and is equipped with safety dogs. There are solid sheet-aluminum doors 5 feet high at both ends of each deck. These doors must be in place when the shift is hoisted and are kept on at least one end of each deck at all times (fig. 3). Men riding in the cage when the doors are off on one end must stay back of yellow lines painted on the sides of the cage 3 feet from the end. Each deck has a capacity of 50 men, but the cage is not loaded to capacity. Each deck has two sets of rails and holes in the floor to hold safety stops in place to keep the loaded cars from moving when supplies are transported. Long supplies are lashed to the bonnet frame at the top and held securely at the bottom by blocking with steel pins through blocks and the holes in the bottom of the cage.

The 1-3/4-inch, 6 x 19, modified-Seale-construction, lang-lay hoisting rope is attached to the cage by means of a spelter-filled socket. A safety clamp 18 inches above the socket is attached to the cage by heavy bridle chains to serve as a secondary safety connection (fig. 4).

A flat cable made at the mine is used on the 10-ton counterweight. This cable is 1/2 by 5-1/2 inches in size and is woven of twelve 1/2-inch wire ropes of 4 x 7 construction.

The hoist has a 12-foot-diameter single drum with a 6-foot face. It is driven through herringbone gears by a 500-horsepower induction motor. The hoist is controlled by a power lever, a service brake lever, and an emergency brake

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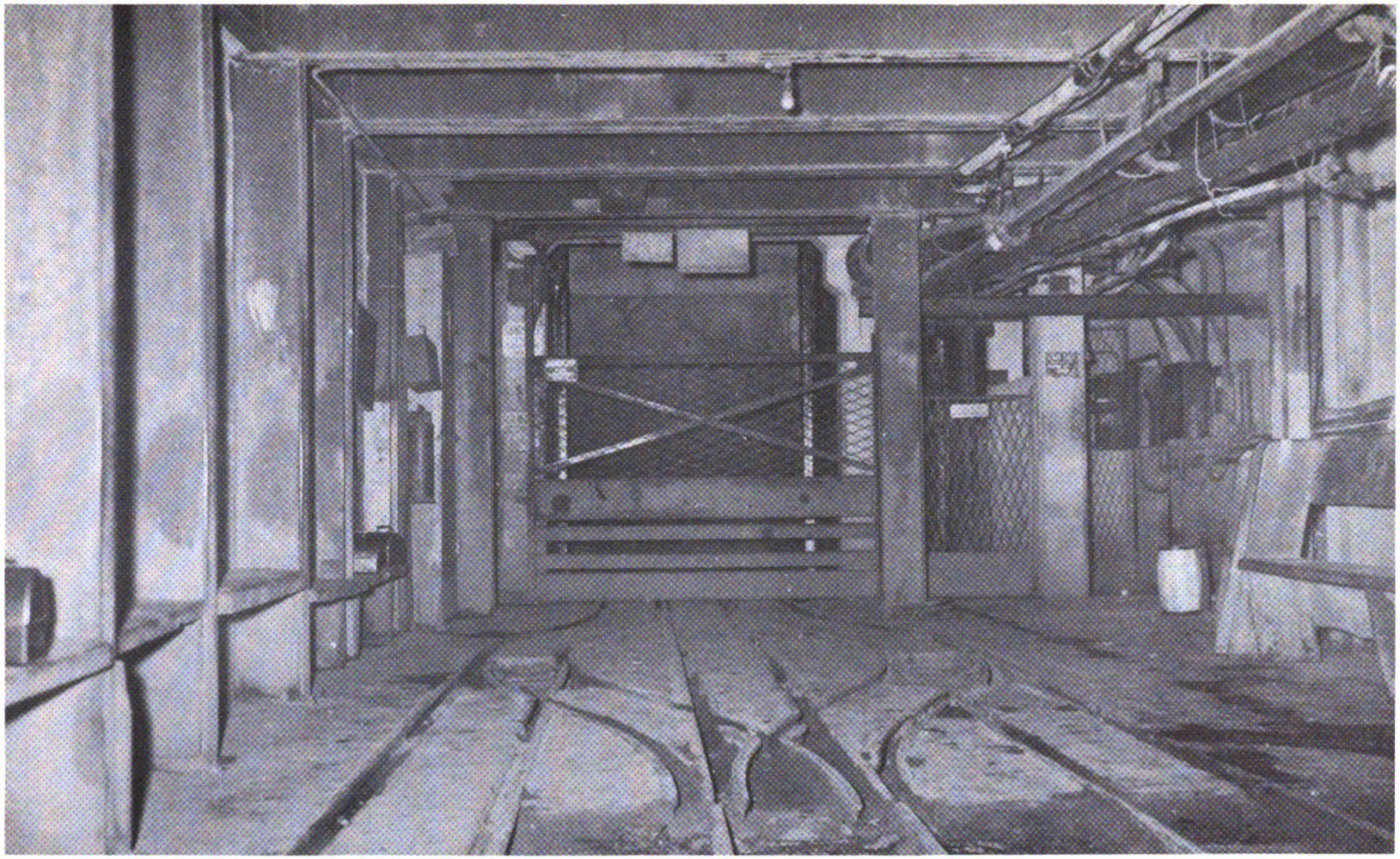

Figure 2. - Station gate on 3,000 level, No. 6 shaft.

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Figure 3. - Door on double-deck cage, station gate, cager pull cord at station, radio signal pull cord, and emergency bell cord in No. 6 shaft.

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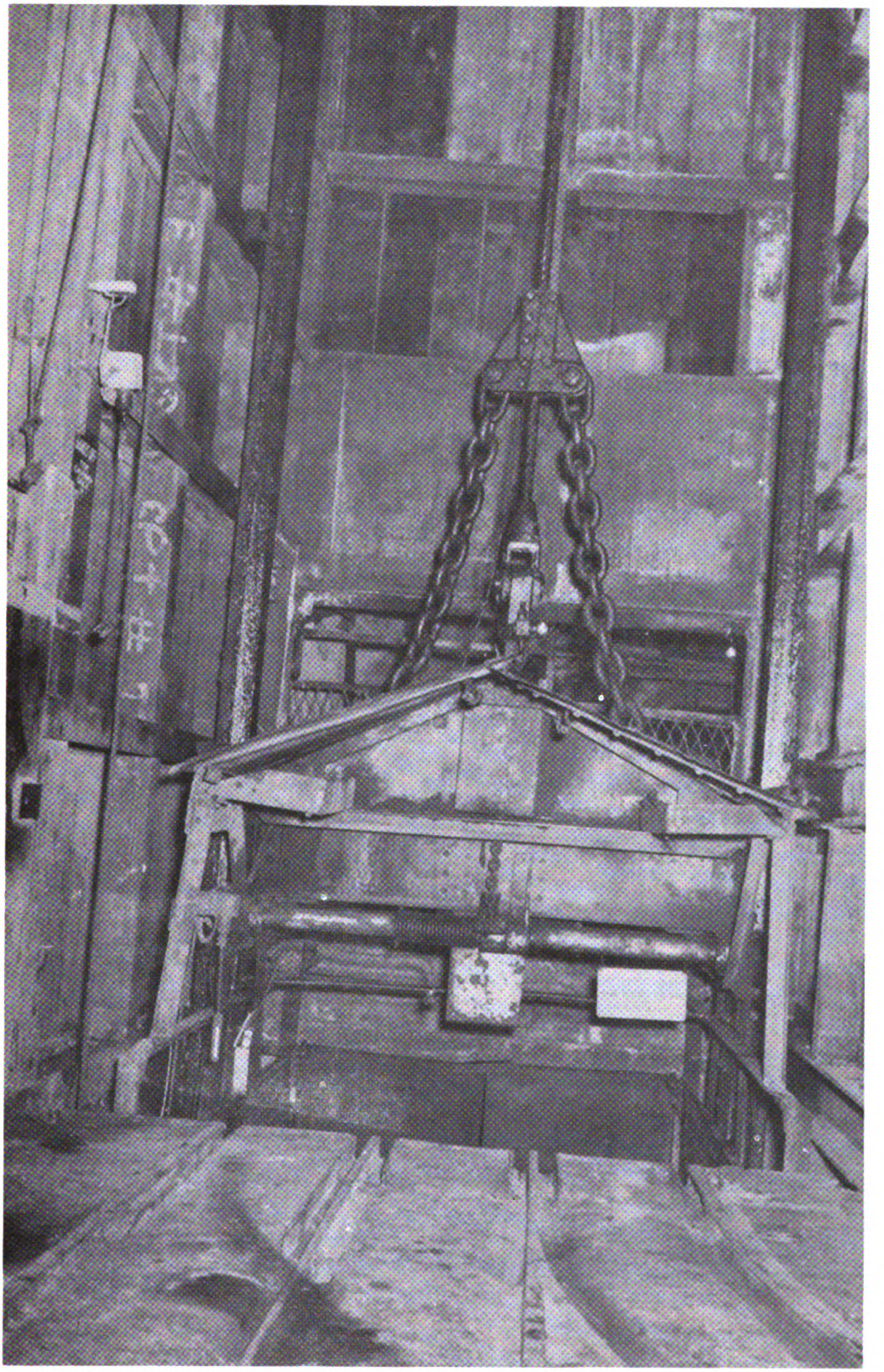

Figure 4. - Rope attachment and bridle chains on cage, No. 6 shaft.

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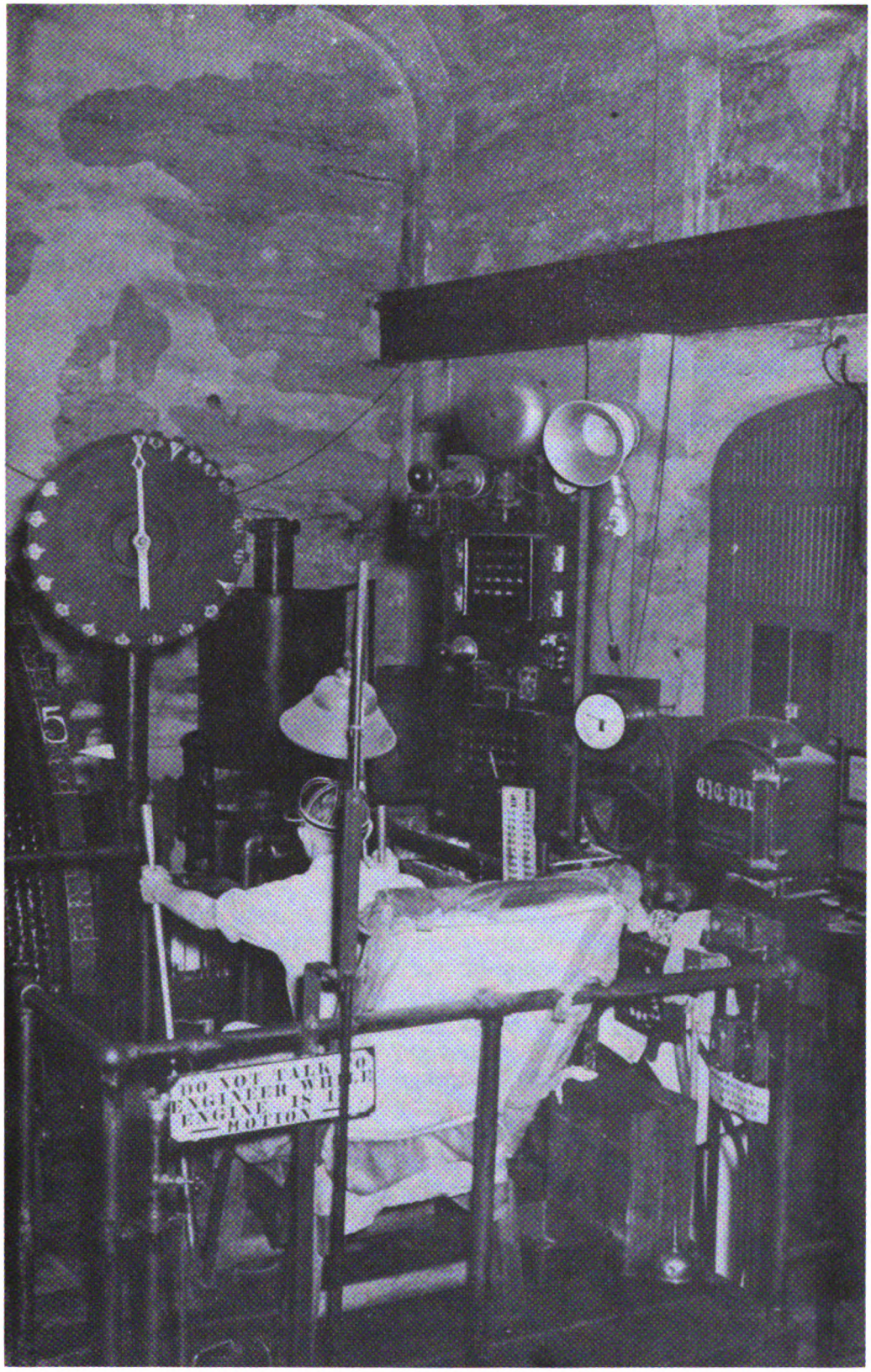

Figure 5. - Hoist engineer's platform on No. 6 hoist showing general level indicator, level markings on hoist drum, and signal panel with annunciator boards.

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lever. The power lever has four positions: lever, neutral, raise, and dynamic brake. A liquid rheostat controls the power to the motor.

The flat cable winds on itself on a separate flanged reel. The sheave wheel on the flat cable is 8 feet in diameter, and that on the cage rope is 10 feet in diameter.

An accurate and reliable indicator of the cage position is placed so as to be in constant view of the engineer. A dial is used as a general indicator, and the drum is marked to show the exact position of the cage (fig. 5). This hoist is equipped with a mechanical recorder also.

The hoist room is large, well-lighted, clean and adequately ventilated with fresh air. The floor, walls, and ceiling are concreted. There is a guard rail 3-1/2 feet high around all machinery and panel boards. A 15-ton crane is available for repairs. The cableway to the sheave room is provided with a stairway with hand rails. The main sheave wheel is provided with a guard; the other sheave wheel is more than 7 feet above the floor and therefore does not require a guard. A small crane is available for making repairs in the sheave room.

Safety Devices

The No. 6 shaft hoist is equipped with three independent brakes. The service brake which acts directly on the hoist drum, is hydraulically operated from a hand lever that must be held open to operate the hoist. If the oil level in the accumulator tank of the hydraulic system should get below a safe level, the power will cut off, and the service brake will set automatically. The dynamic brake, operated off the power lever, causes magnetic braking of the motor by applying 250-volt direct current on the motor winding. This brake can be used in an emergency and also in normal operation to slow down the hoist and preserve the service brake, especially when hoisting heavy loads. The faster the load is moving when this brake is applied, the greater the braking action obtained. The direct-current power required for dynamic braking is supplied by a small motor-generator unit. In case of power failure, this unit must be reset to start, and it is also interlocked electrically with the hoist power-control circuit; so, unless it is in operation, power cannot be applied to the hoist. The emergency brake is controlled from a separate hand lever and operates on the motor shaft. It is a hydraulically opened, weight-closed brake that is held open by the action of a relay, the field being energized by 32-volt direct-current electricity supplied by a bank of batteries. The use of batteries assures operation of this brake in case of power failure. This brake, as the name implies, is for emergency use only.

There is a mechanical underwind and overwind safety device to set the service brake automatically and limit the hoist. There are also top and bottom limit switches in the shaft to limit the distance the cage can travel. These switches cut off the power and set the service brake. To get the cage past these switches, the power must be restored by a hand-operated switch wired for that specific purpose. The brake must be released by applying pressure on a foot pedal.

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Overspeed protection is provided so that the power will cut off and the service brake will set automatically when a speed of 940 feet a minute is exceeded. At a speed of 1,040 feet a minute, the emergency brake will set. When men are being hoisted or lowered, a maximum speed of approximately 800 feet a minute is observed.

In case of a power failure, the service brake will set. Unless the brakes are in operating condition, the hoist cannot be operated. A "safety-run" switch can be used as an emergency power cut-off in case the power lever should fail to operate. When the switch is in the safety position, the power is cut off. The pump for circulating brine solution in the liquid rheostat is interlocked electrically, so that if it is not operating, the safety devices operate and the brakes set so the hoist cannot be moved. If necessary, the motor could be "plugged" to stop the hoist, but with dynamic braking this is not necessary. Plugging in excess can open the overload switches and result in complete loss of power. The hoist motor is provided with adequate overload protection by means of oil switches.

The cage is provided with a slack-rope safety device. If the rope becomes slack, a switch closes automatically, causing a "squawker" to sound in the hoist room by means of a radio-audio signal system.

It is required that the hoistman be notified when heavy equipment is to be hoisted, so that he will have the power on when he releases the brake to prevent slipping. When men are hoisted or lowered at the change of shifts, an electrician or a mechanic is on duty in the hoist room. He watches the level indicator and is prepared to throw the safety switch that cuts off the power in case of an emergency. An All-Service gas mask is kept on hand at the hoist engineer's platform for emergency use.

No. 8 Service and Ore-Hoisting Shaft and Hoist

This is a timbered shaft with two and a half compartments from the 2,850 level to the 3,300 level and three compartments from the 3,300 level to the bottom of the sump at the 4,630 level. The hoist room is on the 3,000 level. The shaft guides are of Douglas fir.

Heavy, steel, hinged gates with rail bumpers are installed at the shaft stations, and men waiting to be hoisted are required to stay behind yellow lines painted on the station walls. The stations on all levels are well-timbered. The gates at the ore pockets are operated by air.

A skip with a cage beneath, is used for hoisting in each of two compartments 5 feet 2 inches by 5 feet 4 inches in size. Skips carry a load of 3.9 tons, which is slightly less than their capacity. Each cage holds nine men and is provided with folding gates. While men are being hoisted, protective screens are hung on the gates after they are closed to prevent men from putting an arm through the gate. Special guards built on the gates afford protection to the men's feet from the hazard of sticking the toes out of the cage (fig. 6). Chains and bars are used to tie supplies in the cage. Each skip is provided with a set of safety dogs.

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Figure 6. - Folding gates with protective screens and toe guards on cage, No. 8 shaft.

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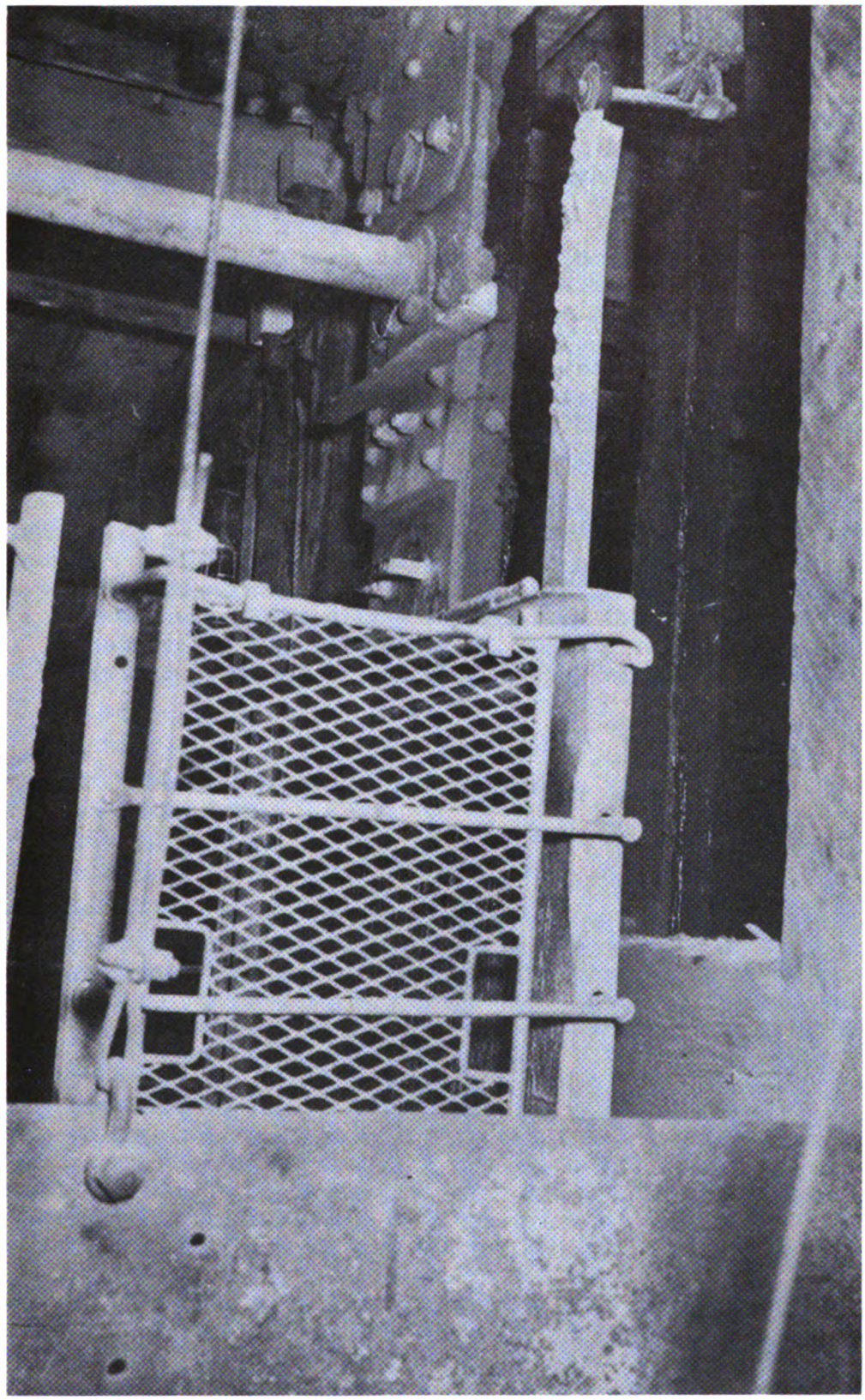

Figure 7. - Arm on cage about to engage limit switch above the 3,000-level station, No. 8 shaft.

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The 1-1/8-inch, 6 x 19, Seale-construction, lang-lay hoisting rope is attached to the skip by means of a spelter-filled socket, and bridle chains serve as a secondary safety connection.

The double-drum, single-clutched hoist is driven by a 350-horsepower induction motor through herringbone gears. Each drum has a 3-foot 4-inch face and is 7 feet in diameter. The motor is provided with an overload protective device.

The hoist is controlled through a power lever, a clutch lever, and two brake levers. The power lever has only three positions: lower, neutral, and raise. Power fed to the motor is controlled through a liquid rheostat.

Dial indicators, in good view of the hoist engineer, serve as general level indicators, and the drums are marked to show the exact position of the cages and skips. A mechanical recording machine records the position of the cages throughout the day.

The hoist room has a concrete floor, lagged ceiling supported by I-beams on steel columns, and gunited walls. It is adequately ventilated, kept clean, and is quiet enough so that the engineer can easily hear the signals. A guard rail 3 feet high surrounds the machinery. A crane handles heavy equipment. A stairway with hand rails passes through the cableway to the sheave room. The sheave room is well-timbered, and the walls are gunited. The 6-foot-diameter sheave wheels are completely guarded with 3/8-inch mesh screen.

On the hoist, one drum may be clutched in or out, and the other drum is solid to the shaft. Men and equipment are handled only through the compartment served by the solid drum.

Safety Devices

Each drum of the No. 8 shaft hoist is equipped with a separate service brake. These brakes are air-operated to release and weight-operated to close and act directly on the hoist drums. They operate on the compressed air furnished to the mine, but an auxiliary compressor is maintained for use in an emergency. If the air pressure should drop from a normal of 50 pounds to below 40 pounds, the brakes will set automatically. The brake is interlocked with the clutch, so that the brake sets automatically if the clutch is disengaged. Only one brake is required in normal operation, and the other brake serves as a spare in case of emergency. The pump on the liquid rheostat for recirculating the brine solution is interlocked with the safety devices, so if the pump is not operating, the brakes set, and the hoist cannot be operated. In case of emergency, the motor could be reversed to stop the hoist. If the power should fail, the brakes would set automatically.

A mechanical overwind and underwind device on each drum limits the amount of cable that can be either let out or reeled on the drums. A limit switch above the 3,000 station and one above the drum control the distance the cage and skip may be raised in the shaft (fig. 7). These switches cut the power and set the brakes on the hoist. To pass the limit switch above the station while hoisting ore, a foot pedal must be held down. A green signal light will glow

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on the engineer's stand when this switch is open. A contact switch in each compartment a few feet below the 3,000 station is scrivated by the skip, causing a bell to ring in the hoist room. This serves to put the hoist engineer on the alert as the skip approaches the shaft collar.

A governor regulates the hoist and limits the rope speed to 710 feet a minute.

In case the power lever should fail to operate, the power can be cut off by an emergency switch. When men are hoisted or lowered at the change of shifts, an electrician or mechanic is on duty in the hoist room and is prepared to open the emergency switch.

Signal Systems

There are two separate signal systems for No. 6 shaft. The cage signal system is used only by the cager to notify the hoist engineer when and where to move the cage. The call signal system is used by anyone who wishes to be hoisted. The cage signal system devices are operated by pull cords, which are behind the station gates, whereas the call signal is operated by a push button at each station. "Hands-off" signs are posted at the station pull cords. Signals required by the State mining code are used.

There are three separate means of communication for the cage signal system: the station system with the pull cord on each level, the radio-audio system with the pull cord on the cage, and the emergency bell-cord system with the pull cord hanging down the shaft (fig. 3).

The station system is operated on 32-volt direct current supplied by a motor-generator set. This set starts automatically when power has been restored after a power failure. There are two annunciator boards on the hoist signal panel, each of which has a number for each level (fig. 5). When the cager signals from a level, an arrow will automatically point to the number on the lower annunciator board to indicate the level from which he is signaling. The hoistman does not reply to the signal unless he does not understand it, in which case he will so indicate with two flashes on the call-reply system. The cager will then repeat his signal. The lower annunciator board serves as a check for the hoistman to keep him from moving the cage unless the cage signal is given from the level on which he has the cage spotted. The hoistman clears the lower annunciator by pressing a button.

The radio-audio system is operated on a 6-volt automobile battery carried on the cage. The pull cord with a gripper switch, which must be squeezed to operate it, is attached to a set on the cage that transmits the signal through the cable. A small audio amplifier in the sheave room picks up the signal from the cable. The signal is indicated by a "squawker" on the top of the signal panel in the hoist room. A small white light under the "squawker" also flashes when a signal is given. The hoistman does not reply to the signal but proceeds to fulfil the request. This system is for emergency use only and can be used while the cage is in motion. In case of power failure, this system can still be used. The slack-rope warning also is given in this system.

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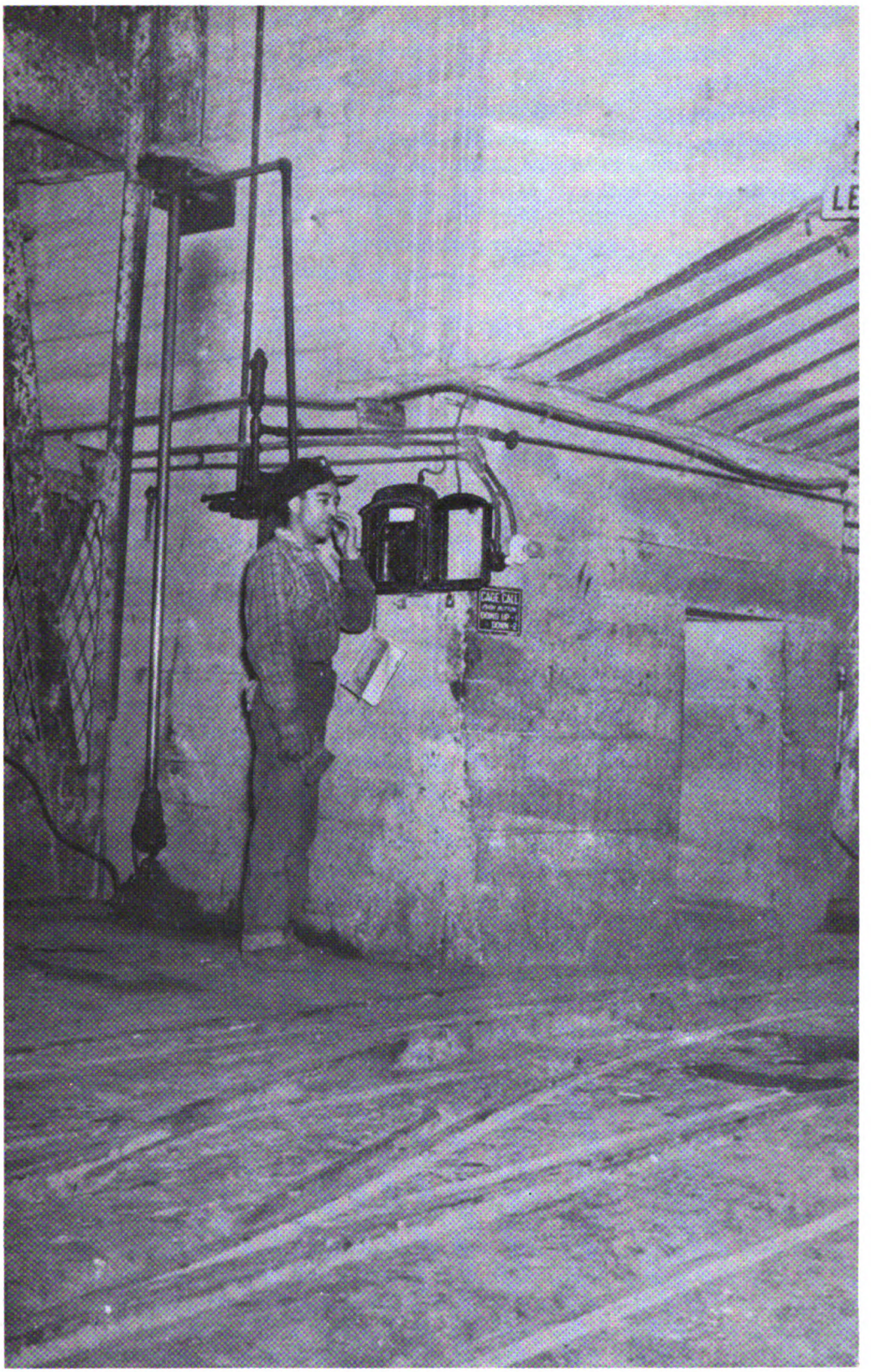

Figure 8. - Cage call signal button and light and cager at telephone on the 500-level station, No. 6 shaft.

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The emergency bell cord in the shaft is connected to a bell in the hoist room at the bottom of the cableway. This system of signaling is used by the shaft repair crew and can be used by the cager in an emergency.

When the cage is on the 500 level and the gate on the subway is open to load men on the bottom deck, the station signal system will not operate, and a red light glows on the signal panel to warn the hoistman. When the bottom deck is loaded and the gate is closed, the cager on the bottom deck gives a release signal to the upper-deck level on a pull cord provided for that purpose. The cager on the upper deck then gives the proper signal to the hoistman on the station signal system, releasing the cage.

A yellow line is painted at eye level on the cage and on the shaft at each station for the convenience of the cager in spotting the cage.

The call signal system, used to call for the cage, also is operated on the 32-volt direct current supplied by the motor-generator set. The level from which the call originates will be indicated by an arrow on the upper annunciator board. A small bell on the upper left corner of the signal panel will ring also when the call signal is given. The hoistman answers the call by pressing a button once which flashes a white light on all stations (fig. 8). The hoistman puts a marker on a punchboard at the bottom of the signal panel to keep a record of the cell and clears the upper annunciator board by pressing a button.

As in No. 6 shaft, there are two separate signal systems for No. 8 shaft - the cager signal and the call signal. These systems, with the three separate means of communication (station, radio-audio, and emergency bell cord) for the cage signal system are essentially the same as in No. 6 shaft, except that annunciator boards are not provided.

The No. 5 shaft signal system is operated by pull cords at each level and at the loading pocket stations. The signal is recorded on a signal panel in the hoist room by a large bell and an annunciator board with a separate signal panel for each hoisting compartment. When a skip is loaded, the skip tender must give a signal of one bell to indicate it is ready to be hoisted. In the event of a hang-up in the loading cartridge, the long elapse of time indicates to the hoist engineer that there is trouble, and he will not move the skip until he receives an additional clearance of four bells.

In addition to the signal systems, telephones are provided for communication between the hoist rooms and the various stations, sheave rooms, selector room, and loading pockets in all the shafts.

Fire Protection

A light switch in a room adjacent to the No. 6 hoist room controls all the lights in the mine above the 3,000 level. In the event of a fire, the hoist engineer flashes the fire signal on the mine lights. To notify the hoistman of a fire on any level, the fire signal is given on the call system. The fire signal is given on the mine lights below the 3,000 level by the No. 8 hoist engineer.

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Carbon tetrachloride and soda-acid fire extinguishers and water taps and hose are provided for fire protection for the hoist rooms. The No. 5 hoist room also is provided with steel doors.

A sprinkler system in the No. 8 shaft is operated daily at lunch time to wet down the shaft and can be used in case of fire.

Each shaft station is provided with a water tap and hose and in some instances also with fire extinguishers.

SAFETY INSPECTIONS

Hoisting equipment is inspected periodically by the elec tricians, cablemen, mechanics, boilermakers, shaft crews, and supervisors. In addition, the hoist engineers are required to make certain tests and be alert for defects, which are reported immediately to the general shop foreman, chief electrician, or cableman.

Various cursory inspections are made daily, and other thorough inspections are made weekly, biweekly, monthly, or bimonthly; detailed written reports on the thorough inspections are submitted. Special inspections are made at any time following an accident or near accident involving either personnel or equipment or both. An accident or near accident must be reported immediately, and work is stopped until inspection and repairs are completed.

The following inspections are made daily:

1. Inspection by the cablemen of rope fastenings, wrap of ropes on hoist drums, and the wire ropes, with special attention to that portion between the cage or skip and the hoist drums.

2. Inspection of sheave wheels and idlers by mechanics. They are lubricated, also.

3. Inspection of cages and skips by boilermakers.

4. Inspection of No. 6 shaft by a supervisor.

5. Inspection of mechanical parts on hoists by a mechanic. No. 6 and No. 8 hoists are lubricated, also.

6. Inspection by an electrician of electrical equipment on hoists, including the radio-audio signal systems.

7. Limit switches are tested by hoistmen at the beginning of the shift.

The following inspections are made weekly:

1. Inspection of safety dogs, ropes, and rope fastenings by the cablemen.

2. Inspection by the boilermakers of cages, skips, rope fastenings, safety dogs, shaft guides, pockets, counterweight cage, and the counterweight guides and compartment.

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3. Inspection of No. 8 shaft, stations, and loading pockets by a supervisor and a cager.

4. Inspection by mechanics of all mechanical parts of hoisting equipment.

5. Inspection by electricians of all electrical parts of hoisting equipment. All safety devices are made to operate, especially overspeed and overwind devices.

The following inspections are made biweekly, monthly, or bimonthly:

1. No. 8 skips, cages, pockets, and sheave room, and cableway equipment are inspected by the boilermakers biweekly.

2. No. 5 shaft, pockets, and skips are inspected monthly by the boilermakers.

3. No. 8 manway compartment is inspected monthly by a supervisor.

4. No. 6 and No. 8 shafts are inspected by the boilermakers bimonthly.

Every 6 months, all hoisting ropes except the flat counterweight cable are cut back a minimum of 6 feet on the cage or skip end and resocketed. At intervals of approximately a year, as shown to be necessary by inspections, either three-quarters or one-and-one-quarter turns are cut off the drum end. This is done to change the cross-over point, which usually gets excessive wear. Occasionally, a piece of rope that has been cut off is sent to the factory for determination of the breaking point. Also, at 6-month intervals the hoisting ropes are tested for remaining strength by taking critical measurements and counting broken wires on the worst rope lay. From these data, the safety factor is computed, although they alone are not used as a criterion to determine when hoisting ropes should be replaced. Ropes usually become too short from cutting back before they wear out. Typical safety factors for new ropes and the number of turns left on the drum when the skip or cage are at the lowest point are as follows:

Hoist	Safety factor	No. of turns
No. 5.....	4.2	7
No. 6.....	5.0	4
No. 8.....	5.3	7

Whenever a rope is replaced, the head sheave is measured for proper groove contour for the new rope. For maximum rope life, the filler blocks on the sheave are regrooved if possible or changed when they are excessively worn. The drum grooves also are checked and recut if necessary.

The flat cable carrying the counterweight is not cut back or tested for strength; however, it is inspected weekly and is replaced when it shows excessive wear.

Equipment is by special crews, and no one else is authorized to make repairs.

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Ropes are lubricated when necessary, and the condition of lubrication is recorded in the weekly reports.

CODES OF SAFE PRACTICE

Each phase of operations is covered by specific rules, which are known as the Codes of Safe Practice.3/ Key officials or supervisors were chosen from various departments to write detailed safety instructions in conjunction with the personnel that actually perform the work. The preliminary draft was then submitted to the foreman, superintendent, shift bosses, and the safety department for discussion and was revised before being printed in the final form. A thorough study of all available published information on each subject was made from such sources as:

National Safety Council Safe Practices Pamphlets
National Board of Fire Underwriters
Institute of Makers of Explosives
U. S. Bureau of Mines
Insurance companies
National Electrical Safety Code
Equipment manufacturers
Safety rules of other companies
State laws

Many of the rules are the result of practical experience obtained locally from accidents and near accidents. The codes are revised from time to time as dictated by additional experience or change in conditions.

Employees are furnished with copies of the codes pertinent to their jobs. They are given initial instruction, examination, and periodic reviews on these codes.

The following codes of safe practice have been adopted for the hoisting operations:

Handling Ore and Waste Through No. 5 Shaft
Starting Hoist and Motor Generator Set No. 5 Hoist
No. 6 Shaft Engineer and Cager, Transferring Men and Supplies
Duties of Hoist Engineer No. 6 Hoist from Electrical Standpoint
Attaching Wire Rope Socket No. 6 Hoist
Changing No. 6 Hoist Flat Cable
No. 8 Shaft Hoistman and Skip Tenders

The excerpts that follow are typical of these codes.

3/ Look, A. D., and Sharp, A. A., Safety Practices at United Verde Mine, Phelps Dodge Corp., Jerome, Ariz.: Bureau of Mines Inf. Circ. 7501, 1949, pp. 6-7.

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No. 6 Shaft Engineer and Cager; Transferring Men and Supplies

Part I - Hoist Engineer

Oiling and Inspection of Equipment:

1. The night hoisting engineer shall lubricate the motors and the hoist when the oiler is not on duty.

2. The engineer shall test his service brake and emergency brake during shaft inspection. When testing service brake, it should be applied when the hoist is in motion.

3. At the beginning of the shift, when the service brake is cold, both brakes shall be used when loading men.

4. The engineer shall constantly watch for cable, motor, and brake defects and report them to the shop foreman, chief electrician, or cableman, as the case may be.

5. Hoist engineers shall keep the water in the rheostat at proper level.

Responsibilities and Duties:

1. The hoist engineers shall change shifts in the hoist room.

2. The hoist engineer must be thoroughly acquainted with the State Code of Hoisting Signals.

3. When leaving the hoist, make sure the service brake is firmly applied.

4. The engineer shall not leave the hoist when the cage is loaded.

5. He shall flash the level lights at the stipulated time and answer all station calls.

6. Check the station marks at regular intervals. When giving a station spot, the cager will first spot the cage at the station and then give the signal for that station.

7. When necessary to leave the hoist room, call the cager and instruct him to watch the signal board. To call the cager, flash the station signal or use the telephone.

8. Do not move the cage unless the signals are clearly understood and allow a brief interval of time after the signal is received before moving the cage.

9. When making through trip to the 3,000 level, start slowing down at the 2,850 level.

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10. Should a danger or fire signal be received, signal the cager and after getting the cage released take it to the level from which the signals have been received. Four bells shall be the release signal at all times.

11. As soon as the fire signal is flashed, call No. 8 Hoist Engineer (phone 402-R11) and state: "There is a fire in the Mine."

12. The cage shall not be moved from a station until a station signal or release bell is given.

13. When work is to be done in the shaft, the men doing such work shall personally contact the hoist engineer and inform him of their intentions, and they shall either notify the cager or engineer when they have finished their work.

14. When work is to be done in the shaft, the hoist engineer shall clearly instruct his relief to this effect and he shall also leave detailed written instructions.

15. If at any time the hoist has been idle more than 2 hours, the hoist engineer shall clear the shaft by running the cage through the shaft before hoisting men and supplies.

16. When the cage is released to the hoist engineer, he shall raise it 4 feet above the station level.

17. Slack Rope in Shaft: Men observing slack rope in the shaft shall immediately pull the cage signal and stop the hoist. When a rope is slack, the cage or skip shall not be moved under any circumstances until the hoist engineer and rope foreman have been notified and a thorough inspection has been made.

18. Material or Tools Dropped Down Shaft: If tools or material are dropped down the shaft, have the shaft inspected before proceeding with normal operations.

19. Station Signal Repair: Hoistman must not move cage away from any station while electricians are repairing bells on that station until given release by the electrician.

Good Housekeeping:

1. The hoist engineer shall be responsible for the cleanliness of the hoist room and hoist equipment.

Part II - Cager

Hoisting and Lowering Men:

The cager shall make the following inspections before transferring the shifts:

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1. Clear both decks of all supplies, chocks, wedges, or chains

2. See that the gates are on and properly hung and that the gates opposite the entrace are closed and latched.

   a. Loading cage for lowering shift: The cager shall call the levels and see that the men are loaded in proper sequence. All men for the bottom levels must be loaded on the top deck.

   b. Allow no one on the cage with open lights, tools, or supplies.

   c. The assistant cager on the lower deck will observe the same procedures in loading his deck.

   d. When the lower deck is loaded, the cager on that deck will see that all the men are on the cage.

      (1) Close the station gate securely, so that contact will be made.

      (2) Signal a release to the cager on the upper deck.

      (3) Close the cage door.

3. The cager on the upper deck will -

   a. Close the station gate.

   b. See that all of the doors are closed.

   c. Wait for a clearance from the lower deck.

   d. Give the station signal.

Precautions on Transferring Shift:

1. The cager must be thoroughly acquainted with the State Code of hoisting signals.

2. Stand on the cage deck when giving signals. Do not give signals unless in the clear.

3. No supplies may be carried on the cage with the men.

4. All persons not employed by the company must have passes, which will be taken up by the cager and turned in at the Time Office.

5. See that the cage is spotted on the level and give stop signal before allowing men to get off or on.

6. Allow no horseplay on the cage.

7. Allow no open lights or smoking on the cage.

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8. Permit no one to get on or off the cage until it has come to a stop.

9. Give signals clearly and distinctly. If a signal is followed quickly by a stop signal, be sure the stop signal is understood before allowing man to get on or off the cage.

10. When hoisting the shift, use the same precautions as in lowering.

Handling Men and Supplies During Shift:

1. Men may be transported with tools or limited amount of supplies.

2. Men shall not be transported with a fully loaded cage or with motors, long timbers, rails, drill steel, or empty trucks. Two full truckloads of steel, or approximately 8 tons, shall be a fully loaded cage.

3. Men shall not be handled during shift with explosives on either deck, except such men as are necessary to distribute the explosives.

4. The cage doors shall be kept in place and kept closed except when loading or unloading or when it becomes necessary to remove them for loading trucks.

5. Men riding the cage, who are not engaged in transfer of materials, shall stand back of the yellow line except when the cage gates are closed.

Transferring Haulage Motors:

1. Inform the hoist engineer by phone that a motor is to be transferred.

2. Remove headlight.

3. Spot the cage on the level and open doors.

4. When front wheels of motor are on the center track of the cage, allow the motorman to place controls in neutral, set brakes firmly and get off the motor and cage; then respot the cage.

5. When rear wheels of motor are on the cage, wait until motorman gets off the cage, then respot the cage as before.

6. When the motor is completely on the cage, check the clearance at both ends, see that the brakes are set, the controls in neutral, the plug pulled, and block the motor at both ends.

7. Allow no one on the cage except the motor crew.

8. Give the station signal slowly and distinctly.

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9. In transferring the motor from the cage to the station, stand by to resport the cage and observe the same precautions as in loading the motor.

Loading Long Timbers, Rails, etc., on the Cage:

1. Open cage gate and swing back gate carriage.

2. Place bumper block and floor plates in proper position on the cage deck.

3. Lower cage and throw back the hood.

4. Roll truck of timber into position in front of cage.

5. Block timber turck, front and rear.

6. Place timber hooks on timber about one-third of the distance from the front end.

7. Slowly raise the timber with the jib crane.

8. As the timber is raised, the man handling it shall slide the rear end of it from the truck, being careful not to topple the rest of the timbers and not to get in front of moving timber.

9. Stand to the rear of the timber as it is slid toward the cage and do not allow any part of the body to be under the suspended timber.

10. Lower timber onto cage; timber should be near center of cage, with top of timber leaning inward. Release crane hooks.

11. Place blocking bar in position. After all of the timbers are stood in position, pass a rope around them and tie to the cage so that timbers will be held in place.

12. Lower the cage hood onto timbers.

13. Raise cage and place empty timber truck on cage.

14. Replace gate carriage and close gate.

Unloading Long Timbers, Rails, or Pipe from the Cage:

1. Remove empty truck from the cage.

2. Lower cage and raise hood, one man to remain on deck with the timber.

3. Release rope from timbers.

4. Lean top of timbers against station floor.

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5. Slide bottom of timbers against bumper block, use a bar to pry the timbers, and avoid heavy lift and possible strain.

6. Bind the timbers about 4 feet from the lower end with a chain and binder; have the binder on the top side of timbers. Brinder may be placed in position when timbers are loaded.

7. For long timbers, rails, or pipe, place another chain around the load near the top to prevent the bundle from spreading.

8. The man on the cage shall climb out of the cage before it is moved.

9. Raise cage slowly until timbers are high enough to load on the truck but not high enough to allow truck stakes to pass beneath the deck of the cage.

10. Place roller in position beneath load before it rests on the cage floor. Place the other roller on the truck. Push truck to proper position beneath timbers and block it securely both front and rear.

11. Shove timbers forward until their front ends rest on the truck and roller. Do not stand in front of the timbers. Use a bar to make proper load adjustments.

12. Lower cage slowly until timbers are completely supported by the truck.

13. Remove chains and binder from the timbers.

14. Remove truck of timbers from the station.

Loading Long Material from below Shaft Collar:

1. Place bumper block and floor plates in position.

2. Lower cage and raise hood.

3. Raise cage deck to station level.

4. Roll truck of material onto cage or near cage. Lay material on the deck and station floor, being careful to keep the hands and feet in the clear as material is dropped from the truck.

5. Slowly lower the cage until the material stands upright on the deck. No one shall remain on the cage while it is lowered.

6. Lean the material against the cross bar and lash it securely.

7. Lower the hood against the material.

8. Allow no one on the cage except the men engaged in transferring the material.

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Transfer of Materials:

1. The cager shall give all signals to move the cage in the transfer of men or material. The assistant cager shall give signals only when instructed to do so by the cager.

2. See that trucks are properly loaded.

3. Block trucks on the cage, check shaft clearance, and close the doors when possible.

4. Notify the hoistman if heavy loads of steel or othermaterial are to be transferred and respot the cage as required.

5. Allow no one to ride with or on top of trucks or cars, either loaded or empty, except supply crew needed in transferring such materials, and they shall be allowed sufficient riding space.

6. Men may ride one deck with trucks on the other deck.

7. In event that trucks are loaded on both decks, the cager will give a through signal and dispose of same before transferring men.

8. Spot the cage as it descends to the station, and if possible do not allow it to pass the station so that it must be raised again.

9. When moving trucks on or off the cage, make sure that the cage is properly spotted. Three inches shall be the maximum difference in elevation between the cage and station tracks.

10. Men may assist the cager in the transfer of materials only when asked to do so by him, and the cager will make sure that they understand what is to be done.

11. Keep the cage spotted, so that the transfer of weight and movement of the cage will not upset the truck or catch the end of it on the cage floor.

12. Keep the feet and hands in the clear at all times.

13. Allow no one to get on or off the cage while it is being respotted.

14. Dropping Material Down Shaft: If materials or tools are dropped down the shaft, cager shall immediately report the same to the hoist engineer, who will have the shaft inspected before continuing with the regular work.

15. Do not leave the hoist motor unattended when pulling loads to the shaft.

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Transfer of Dynamite:

1. The cager shall notify the hoist engineer that dynamite is to be transported through the shaft.

2. Four loaded powder trucks shall be placed on the bottom deck and two loaded powder trucks on the top deck. The cager will stand by and respot the cage as may be necessary during the loading operation.

3. The cager will block the trucks and check for shaft clearance.

4. Where four trucks are loaded on the cage, the doors must be removed. They must be replaced immediately after transferring the trucks.

5. The cager and the man distributing powder will ride on the top deck with the two loaded powder trucks.

6. The cager shall ring the station signals slowly and distinctly.

7. The cager will stand by during the unloading operation to respot the cage when necessary, to prevent rough handling of trucks.

8. The cager shall permit no tools or supplies except dynamite on the cage.

9. No one but the distributing crew shall ride with dynamite.

General:

1. The cager will close the station gates and release the cage when leaving it. Four bells shall be the release signal at all times. The cage shall then be raised about 4 feet above the level. The cager shall signal for the cage to be lowered when he wishes to get on.

2. When cleaning stations, the cager shall be continuously alert for signals from the hoist engineer. When the call is given, he shall get on the cage immediately and release the cage to the hoist engineer.

3. Upon receipt of a fire or danger signal, the cager shall get on the cage and release it immediately.

4. Good Housekeeping: The cager shall be responsible for the orderliness and cleanliness of the cage.

5. Stations: The cager shall keep the station platforms clean and all stations shall be kept clear to the point designated by the yellow line.

6. Inspection and Repairs: Engineers, shaft inspectors, or repair men shall personally notify the hoist engineer when work is to be done in the shaft. They shall notify thehoist engineer or cager when they have finished the work.

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7. If anything is dropped down the shaft, notify the boss and hoist engineer, so that immediate inspections may be made.

8. Supplies: The cager shall keep a supply of station light bulbs on the cage. He shall keep three Edison electric cap lamps on the 500 station for replacement of defective lamps.

9. Station Marks: The cager will first spot the cage at the station and then give that station signal, which will signify to the hoist engineer that the cage is correctly spotted.

10. The cager shall keep a lighted lamp on the cage at all times.

11. The cager shall stay with the cage at all times.

12. Use radio signal for emergency stops. Try signal on every shift.

13. If the radio signal should fail, use the shaft bell rope when giving a signal between levels.

14. Reports: The cager shall make note of any defects in the cage doors, gates, signals, or guides and report the same to his boss before going off shift. Any serious defects shall be reported at once.

Coordination with Hoist Engineer:

1. Should it become necessary for the hoist engineer to leave his hoist, the cager will release the cage, go to the hoist room, and watch the signal board.

2. The cager shall notify the hoist engineer when any heavy material is to be transferred.

3. The cager shall give the hoist engineer station spots at periodic intervals.

4. Cooperate with the hoist engineer in the safe and efficient transfer of men and supplies.

5. Shaft Inspections: When shaft is being inspected, hang "KEEP OFF" sign on the deck where it can be plainly seen.

Handling Ore and Waste Through No. 5 Shaft

Part I - Hoist Engineer

Orders to transfer muck shall be received from the shaft foreman or general foreman. Special work or repair work shall be discussed and outlined with the skip tender or shaft repair crew at the beginning of the shift.

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Lubrication and Inspection of Equipment:

1. For lubrication and inspection of hoist equipment, refer to "Standard Practice for Starting Hoist and Motor Generator Set."

2. Be careful to have a firm footing and handhold when climbing over machinery. Do not lubricate the hoist while it is in motion.

3. Inspect cable and brakes and report any defects at once.

Responsibilities and Duties:

1. He shall clear the shaft before starting hoisting operations or before anyone rides the skip if hoist has been idle for several hours.

2. Keep count of the number of skips loaded, and notify skip tender when pocket is full.

3. If skip is not empty after dumping, as indicated by the motor or ammeter, stop the skip at the pocket, so that the skip tenders may examine it and clear the skip.

4. Four bells shall be the release signal, except for transferring muck. When transferring muck, the release signal shall be one bell.

5. Upon receiving a release signal of 4 bells, the skip shall not be moved until it is clear that no other signal is intended.

6. No work shall be done on one drum while the other drum is in motion.

7. Hold no conversation with anyone while the hoist is in motion or while attending signals.

8. Shall not leave platform while the hoist is in motion.

9. Pull each skip to the limit switch every day.

Part II - Skip Tender

The skip tender shall receive his orders from the shaft foreman or general foreman, and he shall proceed to the 1,000 level, where he can discuss and outline his work with the hoist engineer. Should any work have to be done that is not in the regular routine, he will inform the hoist engineer so that the latter may know what is being done.

The skip tender shall be responsible for the work and safety of his crew. He shall instruct his helpers in the proper method of doing the work.

Signals:

The skip tender shall know the State Code of Mine Signals and the proper method of sending signals.

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Equipment Inspection:

1. Cable fastenings.

   (a) The cable fastenings shall be inspected daily.

   Skip tenders shall inspect fastenings, platform, and rollers when cableman is not present.

   (b) The hoist engineer shall clear the shaft by running the skips through it before hoisting operations commence.

2. Skips.

   (a) The skip tender shall examine the skips and ascertain if they are empty.

   (b) If skips contain an appreciable amount of muck, they shall be cleaned before hoisting operations are started.

3. Cleaning skip.

   (a) Spot skip at 1,000 level.

   (b) Goggles shall be worn while cleaning skips.

   (c) Loosen the muck with a blowpipe.

   (d) When muck is loosened, signal engineer to dump skip and close the shaft gate.

   (e) Examine the skip and, if it is clean, release if for clearing the shaft.

4. See that the selector throat and pocket are clear and that selector is set properly for the type of muck to be transferred.

   Ride the proper skip; do not step across the shaft to enter the selector room.

Transferring Men and Materials:

1. Men shall ride skip platform.

2. Be sure that shaft gate is closed.

3. See that men and material are in the clear before giving signal to move skip.

Loading Skips:

1. Wear a respirator when loading skip or cartridge.

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2. See that skip platform is raised and latched.

3. Unlock loading-pocket air valve.

4. Turn on sprays.

5. See that guards are in place and partner is in the clear.

6. Open chute gate and load cartridge, being careful to watch for and remove any long timber, steel, powder, or other materials that may appear in the muck.

7. When cartridge is filled, close chute gate and turn off spray.

8. See that skip is properly spotted. To spot skip, stop it at the proper place and then give station signal.

9. Open cartridge gate and fill skip.

10. Close cartridge gate.

11. Signal release of loaded skip.

12. Leave some muck in the chute; do not pull it empty.

13. The skip tender shall immediately telephone the hoist engineer if muck is coming down the shaft, and muck-hoisting operations shall cease. The skip tender shall then go to the selector room and examine the bin and chute. The skip tender shall notify the hoist engineer when ready to resume hoisting.

14. If chute pocket is empty, bar down enough muck to fill it, or block the gate. No work shall be done below an empty chute until it has been blocked.

Freeing Hung-up Chute:

1. Muck may be loosened by using a blowpipe or bar; in no event shall fire hoses or high-pressure water be used to free hang-ups in the loading chutes or cartridges.

2. Key rock may be barred loose, care being taken not to get the hands in the chute and to keep out of the way of the bar and flying rocks when muck is loosened.

3. Blasting chutes.

Should the above method fail to loosen the muck, it must be blasted. Due precaution shall be taken in placement and quantity of powder being used, so that doors and chutes are not damaged. If they cannot be loosened by ordinary blasting, notify the foreman.

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(a) Procure powder and primers from the nearest magazine. Fuse shall not be less than 5 feet in length. Fuse and primers must be brought in separate sacks.

(b) Return all unused powder and primers to their respective magazines. No powder or primers may be kept at the working place.

(c) Insert primer in powder and tie in place.

(d) Tie bomb to a blasting stick of proper length with cord provided for that purpose. Do not use fuse for tying.

(e) Place blasting stick with bomb in the chute and watch for a sudden rush of muck.

(f) Spit fuse, guard entrances, and stand in the clear.

(g) Remove powder or primers from the vicinity of burning operations.

4. Releasing hung-up skip at loading pocket.

(a) Call up the hoist engineer and discuss with him the procedure of freeing the skip.

(b) Use a bar and free the rock if possible.

(c) If rock cannot be freed with the bar, give signal (2 bells) slowly and lower skip 2 or 3 feet.
Caution: If skip does not move when signal is given, to lower, give stop signal immediately and do not allow the cable to become slack.

(d) After skp is lowered a short distance, give signal (3 bells) to raise it slowly.

(e) If skip is not freed by lowering and raising it, the rock should be blasted. Use the minimum amount of powder and place it on the rock, where it will not damage the skip plates or the shaft.

5. Muck hung up at the dump.

(a) Put on safety belt and bar it loose if possible.

(b) If dump cannot be freed by barring, punch a hole in the muck with the bar and blast it down.

(c) Use proper precautions in amount of powder and placement of shots when blasting.

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6. If skip does not dump clean.

   (a) If skip is not empty when returned from dumping, bar the muck loose, if possible, and if this cannot be done, place a small amount of powder in it and blast it loose.

   (b) Do not dump a full cartridge into a partly empty skip, as this causes the skip to overflow, and the spill may jam the skip.

   (c) If skip is completely filled, stop it at the station and level it off to prevent spill. Throw the excess muck back into the chute.

Changing Selector:

When changing to chutes that contain a different type of muck, the selector must be set for the proper bin.

1. See that skip is dumped. Do not ride on skip loaded with muck.

2. Signal for skip to be spotted on level.

3. Get on the south skip platform and then give the signal for selector room.

4. Move selector to proper bin.

5. The skip tender shall immediately telephone the hoist engineer if muck is coming down the shaft, and muck hoisting shall cease. He will then proceed to the selector room and examine the chute and bin.

6. The skip tender shall telephone the hoist engineer when ready to resume hoisting.

Cleaning Sump Pocket:

Muck from the sump pocket is transferred from the chute at the bottom of the pocket to a car. The car is dumped into a skip, which is hoisted to the 3,000 level and dumped into the ore pocket.

If excessive water is present, the muck must be loosened to let the water drain out.

1. Open chute and punch a hole in the muck with a bar.

2. Stand in the clear and blast the pocket.

3. See that water has drained before pulling chute.

4. When pulling chute, watch out for a surge of muck or water.

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5. Work from side of chute to avoid being struck by rocks on bar.

6. Have adequate ventilation while working in the pocket.

Cleaning Spill Pockets:

1. Spot skip at spill-pocket chute.

2. Open spill-pocket gate with the bar.

3. Use bar or blowpipe to work the muck from the spill pocket.

4. After pocket has been emptied, see that gate is closed properly.

Housekeeping:

The skip tender shall be responsible for the cleanliness and orderliness of the shaft-pocket loading platforms and selector room. He shall see that all tools and hoses are in their proper places and that no unnecessary material is left on the platforms.

Reports:

The skip tender shall report to the foreman any skips, gates, doors, chutes, or guides in bad order or any other equipment that may need attention.

Obvious Hazards:

1. Falling rock--getting too close to shaft or putting hands in chute while muck is moving.

2. Getting on or off skip or cage while in motion.

3. Failure to close station gates.

4. Faulty equipment. Failure to inspect and report same.

5. Improper method of doing work. Lack of training or instructions.

6. Failure to give signals properly.

7. Powder or primers in the muck.

8. Powder or primers left in sacks or lying loose.

9. The improper use of explosives.

10. Riding on skip or crosshead instead of platform.

11. Riding on heavily loaded skip.

12. Passing through shaft to selector room; riding the wrong skip.

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Shaft Inspection by Repairmen:

1. No shaft-repair work shall be done in the shaft until it has been inspected from the selector room to the point where work is to be done.

2. Shaft repairmen shall contact the hoist engineer and inform him of their work and method of procedure.

3. Shaft repairman shall advise hoist engineer of any change in the routine.

4. Release skip when you are through with it and do not leave it spotted on the station.

5. Inspection procedure.

   (a) Thoroughly inspect fastenings, platform, and skip before working on same.

   (b) Ride to the selector room on the skip platform.

   (c) Clean down all loose material or rocks at selector room.

   (d) Attach a 200-foot rope to the station signal rope.

   (e) Get on working platform and proceed slowly through the shaft, cleaning down all loose material.

   (f) Examine station doors and, if spill is present, open the door and clean off the spill. Be sure the door is closed tightly.

   (g) Stop at each loading pocket and examine cartridge gates and chute gates. The gates should be closed and some muck left in the chute.

   (h) Examine spill pockets and remove spill if pockets are full.

   (i) Report to the foreman any unsafe condition or equipment in need of repair.

TRAINING OF HOIST CREWS

In picking a man to train as a hoist engineer, consideration is given to the man's intelligence, ability to handle the job, his record in the mine, and his character and habits. Before starting training and once a year thereafter, the man must pass a rigid physical examination given by the company physician. A new man usually starts as student hoist engineer and he will spend from 6 to 10 weeks under supervision of the regular hoistman operating the hoist part of the shift. During the period he must learn the State signal code and the Codes of Safe Practice that are applicable. While the student is in training, he is given an examination and review on the pertinent codes by the safety department.

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the period 1935 to 1942, inclusive, based upon the total man-hours for mines. Compared with this figure and calculated on the same basis, the quency rate for hoisting accidents at the United Verde mine was 0.24 for period 1935 to 1950, inclusive. As shaft accidents are usually severe frequently fatal, if data were available for comparison on a basis of erity, the record achieved at this mine probably would appear even more ressive.

CONCLUSION

The good accident experience in hoisting at the United Verde mine has n attained by a concerted effort on the part of the mine officials, ervisors, and safety department and the cooperation of the employees to vent accidents. The safety practice at this operation is based on a tinuous program employing the use of specific and detailed codes of safe ctice for each job, proper choice and training of empoyees, periodic safety tings, installation of proper equipment, preventative maintenance with quent and systematic inspections, accident investigations, and close ervision.

terior - Bureau of Mines, Pittsburgh, Pa.

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Care is exercised also in picking men to train as cagers and skip tenders. A skip tender must have worked as a miner and know how to handle explosives. This requirement is necessary because the skip tenders often have to blast hung cartridge chutes or loading pockets. The new man is put to work under supervision of an experienced cager or skip tender and is not allowed to work by himself until he knows the job thoroughly. Training of skip tenders and cagers usually requires 1 week's time. As in the case of the hoistmen, each cager or skip tender must learn the State signal code for hoisting and the Codes of Safe Practice applicable to the shaft in which he is to work. They must also pass an examination given by the safety department.

The safety department keeps a Code of Safe Practice record for each man, which shows the codes issued, reviewed, and the results of examinations. Codes are reviewed once a year.

SAFETY MEETINGS

Safety meetings are held underground and on the surface every month during the work shift. The meetings are held by the various supervisors in separate groups or units, and each unit meeting is attended by 10 to 40 men who work in the same part of the mine or shop. All units hold their safety meetings on the same day.

The supervisors, acting as chairmen, prepare suitable material for the meeting, aided by a suggested outline from the safety department. A report is made of all accidents since the last meeting, instructions on safe practices are given, and attention is called to any poor practices observed. The men are urged to submit safety suggestions verbally, and these meetings are the major source of safety suggestions, which are recorded on a standard form and submitted by the secretary with the minutes of the meeting. The secretary, appointed for each unit meeting, keeps the minutes of the meeting.

SAFETY RECORD

The results of good safe practice are reflected in the safety record in hoisting at this operation. From the time the Phelps Dodge Corp. purchased the mine in 1935 until January 1, 1951, there have been a total of six lost-time accidents and no fatalities. During this time an average of approximately 375 men were employed underground. Besides the lowering and hoisting of these men and others who had occasion to go underground from time to time, a large quantity of ore and materials have been transported through the shafts.

Three of the six accidents occurred while loading or unloading materials and resulted in a total of 116 days' lost time. The remaining three hoisting accidents resulted in 2,715 days' lost time.

These accidents were investigated thoroughly and corrective measures were taken wherever possible.

Published data[4/] on accidents from hoisting in underground metal mines for 1931 to 1942 show that the frequency rate for hoisting accidents was 1.22

4/ Bureau of Mines, Accidents from Hoisting and Haulage in Metal Mines. Metal-Mine Accident-Prevention Course - Sec. 2: Miners' Circular 53, 1945, p. 3.

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